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SPECIFICATION

ELEVATOR EMERGENCY STOP DEVICE

TECHNICAL FIELD

The invention relates to an elevator emergency stop device for effecting emergency stop of the cage when the speed of ascent or descent of the cage exceeds the legally specified speed, and more particularly relates to an elevator emergency stop device that is ideal for application to high speed elevators capable of exceeding 10 m/s.

TECHNICAL BACKGROUND

According to Article No. 129 No. 7 of the Order putting into effect the Building Standards Law of Japan, elevators are required to have installed a safety device which automatically restrains descent of the cage if the speed of the descending cage exceeds a prescribed value. A speed regulator 14 (what is sometimes called a governor) that detects the speed of cage 20 is therefore installed in the machinery room at the top of the ascent/descent path as shown in Figure 11.

In speed regulator 14, speed regulator 14 is arranged to be rotated with ascent/descent of the cage by a means of a speed regulator rope 15 that is wound thereon with a

middle part thereof connected to a safety link 17 of cage 20. The lower part of speed regulator rope 15 is wound onto a speed regulator rope tensioning pulley 16 that applies a suitable tension to speed regulator rope 15.

If a pre-set speed of speed regulator 14 is exceeded, a rope-gripping unit 19 incorporated in speed regulator 14 is actuated to grip speed regulator rope 15. Safety link 17 is thereby actuated, arresting the descent of pulling-up rods 2 of descending cage 20. That is, seen from the side of cage 20, pulling-up rods 2 ascend, causing a wedge-shaped element 3 that is linked to the bottom end of pulling-up rods 2 and is shown in detail in Figure 12 and Figure 13 to be also pulled up, with the result that frictional force is generated between wedge-shaped element 3 and guide rail 1, thereby effecting emergency stop of cage 20.

Figure 12 is a front view illustrating an example of a prior art elevator emergency stop device and Figure 13 is a cross-sectional view along B-B of Figure 12. In Figure 12 and Figure 13, the upper surface of this elevator emergency stop device 18 is fixed to the bottom beam of cage 20. Also, in plan view, not shown, the framework of this elevator emergency stop device 18 is constituted by a pair of pillars, not shown, made of angle steel, welded above and below to an approximately square-shaped top plate 9A and a bottom plate 9B that is of approximately the same shape as this top plate 9A and slightly smaller than in thickness. As shown in

Figure 13, a U-shaped groove 9a into which the head of a guide rail 1 shown by the chain line fits freely is formed in the front middle part of top plate 9A and bottom plate 9B.

As shown in Figure 12, a step 9d is formed on the under-surface at the front end on both sides of top plate 9A, and a land-shaped guide seat 9b is formed on the upper surface at the front end on both sides of bottom plate 9B. Horizontal steps 9c are formed symmetrically with steps 9d of top plate 9A described above on the outside upper surface of this guide seat 9b.

A pair of guide plates 6 are provided on these steps 9c and 9d. Specifically, a pair of guide plates 6 are formed approximately in channel-section shape, with abutments 6a and 6b projecting on opposite sides at their top and bottom ends. Thus, abutments 6a and 6b of guide plates 6 are inserted from outside onto steps 9c and 9d and the opposite faces of guide plates 6 are inclined such that their separation becomes wider in the downwards direction.

Channel-section grooves 6c are formed on the outside of the left and right guide plates 6; as shown in Figure 12, the two ends of a plate spring 7 made of thick sheet formed in a U-shape are freely fitted into these grooves.

A pair of pressure seats 8 are inserted beforehand from the inside at both ends of this plate spring 7. The major parts of the hemispherical portions of the heads of these pressure seats 8 are fitted into hemispherical recesses

formed at the top and bottom of grooves 6c of guide plate 6, so that by pressing these hemispherical portions into the recesses by means of the restoring force of plate spring 7 the attitude of plate spring 7 is thereby maintained.

Reference numeral 2 indicates the pulling-up rods referred to above, which are made of strip-shaped steel. The bottom ends of practically trapezoid-shaped wedge elements 3 are linked through pins with the bottom ends of these pulling-up rods 2. As shown in Figure 12, guide grooves parallel with the outside inclined faces are formed on the outer face sides of the front and rear faces of these wedge-shaped elements 3. Likewise, guide grooves shown in Figure 12 are formed also on the front and rear faces on the opposite side of each of the guide plates 6 mentioned above.

Bent sections on both sides of a holding plate 4A formed approximately in the shape of a gutter as shown in Figure 13 are fitted into guide grooves formed in these guide plates 6 and guide grooves formed in wedge-shaped element 3 referred to above. Shaft sections projecting at both ends of rollers 5A are inserted into shaft holes at an number of locations formed on the center line of front and rear holding plates 4A.

Holding plates 4A are therefore free to move upwards together with rollers 5A by means of the bent sections thereof whereof one side is fitted into the groove formed in a guide plate 6. An identical elevator emergency stop device

18 is also provided on the other side and may further be mounted on the counter-weight.

With an elevator emergency stop device 18 constructed in this way, when the speed of descent of the cage 20 shown in Figure 11 or counter-weight, not shown, exceeds a specified value, speed regulator rope 15 is gripped by rope gripping unit 19 of speed regulator (governor) 14. Pulling-up rods 2 are therefore arrested in advance of cage 20, causing these to be raised relative to cage 20 and guide plates 6. The wedge-shaped elements 3 that abut the bottom ends of these pulling-up rods 2 are thereby raised with respect to the cage 20 or counter-weight. When this happens, the opposite faces of the pair of wedge-shaped elements 3 are pressed against the side faces of the head of guide rail 1, causing the guide rail 1 to be gripped from both sides, thereby arresting cage 20 or the counter-weight.

The rollers 5 that are inserted in holding plates 4A that ascend together with the wedge-shaped elements 3 are incorporated in order to prevent lowering of the pressing force onto the guide rail 1, by reducing the friction between the wedge-shaped elements 3 and guide plates 6, thereby ensuring that the action of raising the wedge-shaped elements 3 takes place smoothly.

Although in general the coefficient of dynamic friction takes a fixed value determined by the material properties of the sliding members and/or the condition of the sliding

surfaces etc, irrespective of the sliding velocity, in the region where the sliding velocity exceeds 10 m/s, it has been experimentally confirmed that the coefficient of dynamic friction decreases with increase in velocity.

However, with the conventional elevator emergency stop device, sliding takes place between the wedge-shaped elements and the guide rail with a pair of wedge-shaped elements being pressed on to the guide rail with a pre-set spring force i.e. always with a fixed pressing force.

Consequently, changes in the coefficient of dynamic friction are directly reflected in changes in the breaking force and in the case of a high-speed elevator capable of exceeding 10 m/s, as shown in Figure 3A, in emergency braking using such an elevator emergency stop device, the elevator speed is high in the initial period of braking and the coefficient of friction is small. The degree of deceleration is therefore small but immediately before stopping the speed becomes slower and the frictional force becomes large, so the degree of deceleration becomes large.

In the Order implementing the Building Standards Law referred to above, a mean deceleration under emergency braking of 0.35G to 1.0G is laid down, so in the case of emergency braking at a speed of above 15 m/s, the deceleration immediately before stopping becomes extremely large, resulting in considerable load on the passengers.

DISCLOSURE OF THE INVENTION

An object of the invention is to provide an elevator emergency stop device wherein the passenger cage can be stopped safely while maintaining a fixed deceleration during emergency braking of a high-speed elevator.

In order to achieve the above object, in an elevator emergency stop device according to an embodiment of the invention the wedge-shaped element comprises a mechanism whereby its dimension in the direction perpendicular with respect to the sliding faces on the guide rail and sliding member is changed in accordance with braking force.

In this way, the braking force of the elevator emergency stop device can be kept constant by adjusting the force with which the wedge-shaped element presses against the guide rail.

An elevator emergency stop device according to an embodiment of the invention comprises: a fixed part having an outside inclined face part of the wedge-shaped element; and a wedge-shaped moveable part having the sliding member; this moveable part being moveable along the inside inclined face part of the fixed part and the upper part thereof being engaged with the fixed part by means of a resilient element.

In this way, the braking force of the elevator emergency stop device can be kept constant by adjusting the width of the wedge-shaped element as a whole by the moveable

part moving along the inside inclined face of the fixed part in accordance with the braking force of the elevator emergency stop device.

An elevator emergency stop device according to an embodiment of the invention comprises a fixed part having an outside inclined face part of the wedge-shaped element and a wedge-shaped moveable part having a sliding member, this moveable part being capable of moving along the inside inclined face of the fixed part and its upper part being engaged with the fixed part by means of a pair of sliding elements sandwiching a resilient element.

In this way, the moveable part moves smoothly over the inside inclined face of the fixed part in accordance with the braking force of the elevator emergency stop device, thereby achieving finer adjustment of the width of the wedge-shaped element as a whole, and so making it possible to keep the braking force of the elevator emergency stop device fixed.

An elevator emergency stop device according to an embodiment of the invention comprises a fixed part having an outside inclined face part of the wedge-shaped element and a wedge-shaped moveable part having a sliding member, this moveable part being capable of movement along the inside inclined face of the fixed part and the upper part thereof being engaged with the fixed part by means of a resilient

element whereof the relationship of load and flexure changes in two steps.

In this way, the moveable part moves over the inside inclined face of the fixed part in response to the excessive braking force of the elevator emergency stop device, thereby achieving finer adjustment of the width of the wedge-shaped element as a whole, and so enabling the braking force of the elevator emergency stop device to be kept fixed.

An elevator emergency stop device according to an embodiment of the invention comprises a fixed part having an outside inclined face part of the wedge-shaped element and a wedge-shaped moveable part having a sliding member, this moveable part being capable of movement along the inside inclined face of the fixed part and the upper part thereof being connected with the fixed part by means of a piston which is given an initial pressure.

In this way, the moveable part moves over the inside inclined face of the fixed part only in response to the excessive braking force of the elevator emergency stop device, thereby achieving finer adjustment of the width of the wedge-shaped element as a whole, and so enabling the braking force of the elevator emergency stop device to be kept fixed.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view illustrating a first embodiment of an elevator emergency stop device according to the invention;

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Figure 2 is a diagram illustrating the construction of a wedge-shaped element of an elevator emergency stop device according to the invention;

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Figure 3 is a view illustrating the braking characteristic of an elevator emergency stop device;

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Figure 4 is a plan view illustrating a second embodiment of an elevator emergency stop device according to the invention;

Figure 5 is a diagram given in explanation of the construction of a wedge-shaped element according to the second embodiment of an elevator emergency stop device according to the invention;

Figure 6 is a plan view illustrating a third embodiment of an elevator emergency stop device according to the invention;

Figure 7 is a diagram given in explanation of the construction of a wedge-shaped element of the third embodiment of an elevator emergency stop device according to the invention;

Figure 8 is a graph showing the load and flexure characteristic of a resilient element of a third and fourth

embodiment of an elevator emergency stop device according to the invention;

Figure 9 is a plan view illustrating a fourth embodiment of an elevator emergency stop device according to the invention;

Figure 10 is a diagram given in explanation of the construction of a wedge-shaped element of a fourth embodiment of an elevator emergency stop device according to the invention;

Figure 11 is a cross-sectional diagram of the elevator ascent/descent path (what is sometimes called an elevator shaft or a hoistway), showing the installation environment of the elevator emergency stop device;

Figure 12 is a plan view illustrating an example of a prior art elevator emergency stop device; and

Figure 13 is a front view of Figure 12.

BEST MODE FOR IMPLEMENT THE INVENTION INTO EFFECT

An embodiment of an elevator emergency stop device according to the invention is described below with reference to the drawings.

Figure 1 is a view illustrating a first embodiment of an elevator emergency stop device according to the invention, being a view corresponding to Figure 11 in which prior art is illustrated. Figure 2A illustrates diagrammatically the

wedge-shaped element 3 of Figure 1. Figure 2A is a diagram of the case where the braking force is small and Figure 2B is a diagram of the case where the braking force is large.

The difference in Figure 1 and Figure 2A from Figure 11 which illustrates the prior art is that wedge-shaped element 3 is constituted divided into a moveable part 3a and a fixed part 3b.

Like the wedge-shaped element 3 of the conventional elevator emergency stop device shown in Figure 11, the fixed part 3b has an outside inclined face section and rollers 5A are arranged at this outside inclined face section, being freely moveable upwards along the inclined faces of guide plates 6. The face of fixed part 3b that is opposite the outside inclined face section is formed with an inside inclined face section with inclination in the opposite direction to that of the outside inclined faces. As shown in Figure 1, parallel guide grooves are formed in the inside inclined faces in the same way as in the outside inclined faces at the front and rear faces near the inside inclined face of fixed part 3b.

Moveable part 3a is of approximately trapezoid shape, with its upper end being wider; it has a sliding portion 11 on the face opposite guide rail 1, and its face opposite the fixed part 3b is formed with an inclined face parallel with the inside inclined face of fixed part 3b. Guide grooves parallel to the inclined face are formed on the front and

rear faces of moveable part 3a in the same way as the guide grooves on the inside inclined face side of fixed part 3b.

Regarding the guide grooves of fixed part 3b and moveable part 3a, moveable part 3a is linked to fixed part 3b in such a way that it is free to be moved vertically by means of holding plates 4B and rollers 5B, with a construction identical with that of holding plates 4A and rollers 5A that link guide plates 6 and wedge-shaped elements 3.

As shown in Figure 1, the top of moveable part 3a is connected with fixed part 3b through a resilient element 10 made of a metal element or the like; the arrangement is such that this can thereby move along the inside inclined face of fixed part 3b with deformation of resilient element 10 in the vertical direction.

Also, resilient element 10 is loosely fixed to fixed part 3b by means of a position-restraining element 13 comprising a coiled spring or the like, so as to maintain its position in the horizontal direction, being maintained by holding plate 4C such that it does not become detached from wedge-shaped element 3.

If the speed of descent of cage 20 exceeds the speed set by speed regulator (governor) 14, the rope-gripping unit 19 incorporated in speed regulator 14 is actuated to grip speed regulator rope 15.

Safety link 17 is thereby actuated, with the result that the pulling-up rods 2 of the descending cage 20 are pulled up relative to cage 20. Due to the relative rise with respect to cage 20 of the wedge-shaped elements 3 that are linked with the bottom ends of pulling-up rods 2, frictional force i.e. braking force is generated between sliding portion 11 of wedge-shaped elements 3 and guide rail 1.

Since the speed of sliding of sliding portion 11 and guide rail 1 immediately after commencement of braking is high, the coefficient of dynamic friction is small, so the braking force is small. The moveable parts 3a are therefore subjected to a comparatively small raising force from the sliding portions 11, so, since the flexure of resilient element 10 is also comparatively small, braking of moveable parts 3a is performed with an equilibrium in the vicinity of the intermediate part of the inside inclined faces of fixed part 3b.

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When, as braking proceeds, the sliding speed of the sliding portions 11 and guide rail ~~10~~ 1 becomes smaller, the coefficient of dynamic friction becomes larger, with the result that the braking force becomes large and the flexure of resilient element 10 becomes larger, so moveable parts 3a are raised relative to fixed parts 3b.

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Since moveable parts 3a rise along the inside inclined faces of fixed parts 3b, their positions in the horizontal direction approach fixed parts 3b (direction away from the

guide rail) i.e. the width of the wedge-shaped element 3 as a whole (X dimension in Figure 2A and Figure 2B) becomes smaller. As a result, the flexure of spring 7 becomes smaller, causing the force with which sliding portion ~~10~~ 11 of wedge-shaped element 3 is pressed on to guide rail 1 to become smaller.

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Since the braking force (frictional force) is the product of the coefficient of dynamic friction and the pressing force, even though the coefficient of dynamic friction becomes large due to the sliding speed becoming small, the force with which the wedge-shaped elements 3 are pressed against the guide rail 1 is decreased, so, as shown in Figure 3B, the braking force of the elevator emergency stop device is kept practically fixed, so emergency stopping of the cage can be achieved in a safe manner without any possibility of the braking force rising in the latter part of the emergency braking. Figure 3A is a view showing the braking characteristic of a conventional elevator emergency stop device and Figure 3B is a view showing the braking characteristic of an elevator emergency stop device according to the invention. Next, a second embodiment of the invention will be described with reference to Figure 4 and Figure 5. Figure 4 and Figure 5 respectively correspond to Figure 1 and Figure 2A of the first embodiment. The point of difference with respect to the first embodiment lies in the

arrangement of rollers 5C constituting sliding elements above and below resilient element 10.

Typically, the braking force of an elevator emergency stop device is 500 kgf to a few tf per wedge-shaped element 3. This load is directly transmitted from moveable parts 3a through resilient element 10 to fixed parts 3b, so that frictional force between resilient element 10 and moveable parts 3a and fixed parts 3b rises to 50kgf to a few hundred kgf.

It is therefore necessary that relative displacement of moveable parts 3a with respect to fixed parts 3b in order to effect fine adjustment of the width of wedge-shaped element 3 by moving moveable parts 3a so as to track changes in the coefficient of dynamic friction during braking should be conducted in a smooth fashion.

In the second embodiment of the invention, smooth movement of moveable parts 3a is achieved by arranging rollers 5C above and below resilient element 10 so as to sandwich resilient element 10, thereby making it possible to perform better fine adjustment of braking force. It should be noted that, instead of rollers, it would be possible to provide wheels, or to coat the sliding faces with silicone or Teflon (which is a trademark of a certain company); furthermore, even in the case of the first embodiment, in which no rollers are provided, the benefits achieved are of course enormously greater than in the prior art practical

example, in which no adjustment of braking force is performed.

Figure 6 and Figure 7 illustrate a third embodiment of the invention. Figure 6 and Figure 7 respectively correspond to Figure 1 and Figure 2A of the first embodiment. The point of difference with respect to the first embodiment is that an initial pressure-regulating element 21 is mounted on resilient element 10 by shrinkage fitting or the like. The internal pressure of resilient element 10 is partially increased by an initial pressure regulating element 21, producing a load and flexure characteristic of resilient element 10 as shown by the polygonal line (1) of Figure 8.

If the mean braking force of the elevator emergency stop device is assumed to be 1 tf per wedge-shaped element 3, the change of braking force produced by change in the coefficient of dynamic friction is roughly about 700 kgf to 1300 kgf. The displacement of moveable part 3a produced by this change in braking force is in the vicinity of the middle of the inside inclined face of fixed part 3b when the braking force is 700 kgf and is in the vicinity of the top of the inside inclined face of fixed part 3b when it is 1300 kgf. That is, only about half of the possible range of movement of moveable part 3a is employed for adjustment of braking force.

Accordingly, in the third embodiment of the invention, up to for example 700 kgf of the example described above,

scarcely any flexure is produced by the initial pressure i.e. moveable part 3a stays in the vicinity of the bottom of the inside inclined face part of fixed part 3b; when the load exceeds 700 kgf, the amount of flexure for this load increases, causing the moveable part 3a to rise along the inside inclined face of fixed part 3b, moving to the vicinity of the uppermost part of the inside inclined face part when the load is 1300 kgf.

In this way, adjustment of braking force can be effected using practically the entire range of movement of moveable part 3a, thereby making it possible to provide a more stable braking characteristic.

Figure 9 and Figure 10 illustrate a fourth embodiment of the invention. Figure 9 and Figure 10 respectively correspond to Figure 6 and Figure 7 of the third embodiment.

The respect in which this embodiment differs from the third embodiment is the provision of a piston 22 in which gas is sealed, instead of the resilient element 10 and initial pressure-regulating element 21.

In the third embodiment, the initial pressure of the resilient element is applied by the initial pressure regulating element, so this initial pressure can only be applied partially, giving rise to a load and flexure characteristic that changes roughly in two steps as shown by the polygonal line (1) of Figure 8.

In contrast, in the fourth embodiment, the load/flexure characteristic can be made to be as shown by the straight line (2) in Figure 8, by employing a piston 22 in which high-pressure gas is sealed.

As a result, in the example described above, up to 700 kgf, the moveable part 3a is positioned at the lowest part of the fixed part 3b, thereby enabling the entire movement range of moveable part 3a to be made use of for adjustment of braking force, so making it possible to provide an even more stable braking characteristic.

POSSIBILITIES OF INDUSTRIAL APPLICATION

As described above, with the embodiment of the present invention, by adopting a construction in which the width of the wedge-shaped elements is changed in accordance with the braking force of the elevator emergency stop device, the force with which the wedge-shaped elements are pressed against the guide rail can be adjusted, so that an elevator emergency stop device can be provided wherein, even though the coefficient of friction changes, the braking force is held constant.

Also, according to the embodiment of the present invention, by adopting a construction of the wedge-shaped element comprising a fixed part having an outside inclined face part and a moveable part formed in wedge shape and

having a sliding member whose upper part is engaged with the fixed part through a resilient element, being capable of moving along the inside inclined face of the fixed part, an elevator emergency stop device can be provided wherein the braking force is maintained constant by adjusting the width of the wedge-shaped element as a whole, by moving the moveable part along the inside inclined face of the fixed part in accordance with the braking force of the elevator emergency stop device.

Furthermore, also according to the embodiment of the present invention, by adopting a construction in which a moveable part and fixed part are engaged, with a resilient body being sandwiched by a pair of sliding elements, the moveable part moves more smoothly along the inside inclined face of the fixed part, thereby adjusting the width of the wedge-shaped element as a whole and making it possible to provide an elevator emergency stop device wherein the braking force is kept constant.

Furthermore, also according to the embodiment of the present invention, by adopting a construction in which the load/flexure characteristic of the resilient body is made such that the flexure is small or zero up to a certain load, but thereafter the load and flexure are in a practically proportional relationship, it is possible to employ the major part of the range of movement of the moveable part for adjustment of braking force, thereby enabling an elevator

emergency stop device with more stable braking force to be provided.

Furthermore, also according to the embodiment of the present invention, by adopting a construction in which a piston in which gas providing an initial pressure is sealed is used as the resilient element, an elevator emergency stop device with even more stable braking force can be provided, as all of the range of movement of the moveable part can be employed for adjustment of braking force.